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Report

Regional capacity building workshop on the water-energy nexus operational toolkit: renewable energy Beirut, 11-12 July 2017

Summary

The regional workshop on the water-energy nexus renewable energy operational toolkit was convened by the United Nations Economic and Social Commission for Western Asia (ESCWA) in Beirut on 11-12 July 2017 to strengthen the capacity of member states to manage water and energy resources in an integrated, sustainable manner. The workshop was conducted within the framework of the United Nations Development Account project, Developing the Capacity of ESCWA Member Countries to Address the Water and Energy Nexus for Achieving Sustainable Development Goals.

The workshop focused on evaluating renewable energy technologies in the water and energy sectors. Participants assessed the use of renewable energy in various operations, including: water pumping, production, transmission and treatment, including mechanical energy (for example, small/large-scale wind turbines, photovoltaic systems and biofuels for water pumping); solar thermal systems for water heating; and water desalination by solar, wind and geothermal energies; enhanced oil recovery; and water usage in electricity production. Key renewable energy technology performance indicators and financial perspectives were discussed.

The objective of the workshop was to build understanding of the water and energy nexus by inviting executives and practitioners from government and public utilities in the electricity and renewable energy and water sectors (including desalination, production, transmission, treatment and waste) to share their expertise. Participants discussed the diverse opportunities and applications for renewable energy in water and wastewater processes in Arab countries, along with the role it plays in producing electricity. Indicators and case studies on the use of renewable energy in desalination processes and the power sector were presented, along with pilot projects and proposed country programmes. Key performance indicators and financial implication for the water-energy nexus were also addressed.

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Introduction

1. The United Nations Economic and Social Commission for Western Asia (ESCWA) is implementing the United Nations Development Account (UNDA) project on Developing the Capacity of ESCWA Member Countries to Address the Water and Energy Nexus for Achieving Sustainable Development Goals. The regional capacity-building workshop on the water-energy operational toolkit: renewable energy was the second technical workshop organized within the framework of this project. A third, technical workshop on technology transfer toolkit, and a second policy workshop, will be convened at the end of 2017 to present the results of country-level pilot projects.

2. This workshop aimed to strengthen the capacity of senior officials in ESCWA member states to manage water and energy resources in an integrated, sustainable manner to help achieve the Sustainable Development Goals (SDGs). The workshop had the following objectives:

(a) Present and discuss the water-energy nexus renewable energy operational toolkit;

(b) Address the potential of commercialized renewable energy technologies to improve water and energy security;

(c) Discuss how to diversify the national energy mix by providing different energy sources that use small amounts of water and encourage water saving;

(d) Explore how to provide modern energy services in rural/remote areas and reduce reliance on fossil fuels as an energy source;

(e) Share the renewable energy experiences of Arab countries to help the region meet demands for water and energy, and implement sustainable development plans.

3. Participants were invited to group sessions to discuss country case studies on the water-energy nexus. ESCWA member states Egypt, the Syrian Arab Republic and Tunisia presented pilot projects on photovoltaic solar-water pumps and micro-hydro turbines. Topics and materials covered are available from https://www.unescwa.org/events/water-energy-nexus-operational-toolkit-RE.

I. TOPICS OF DISCUSSION

4. Presentations and discussions are summarized according to the meeting agenda.

A. RENEWABLE ENERGY FOR WATER AND WASTEWATER APPLICATIONS

5. The first session introduced the water-energy nexus renewable energy operational toolkit. It highlighted the role renewable energy can play in strengthening the security of the water-energy nexus by: reducing water intensive practices in the power sector; improving access to water resources and the reliability of supply; bridging the water gap in arid regions; and replacing traditional water heating. Renewable energy sources, such as solar, wind, biomass and sewage sludge) are used in wastewater treatment processes. Solar energy has particular significance for treating wastewater. Direct solar radiation can be used alongside solar detoxification, combining chemicals and biological methods. In many Arab countries, solar water heating has been installed in homes, and various renewable energy sources have been used in the oil and gas industry.

6. ESCWA gave an overview of renewable energy sources and technologies in the Arab region, highlighting the sector's growth and presenting capacities in wind, solar and water technologies. Electricity demand is increasing due to rising populations in Arab countries, which still rely on fossil fuels to generate about 96 per cent of their energy needs. As regards water, low precipitation levels in the Arab countries mean renewable energy has an important role to play in covering such deficiencies. The share of renewables in the

total energy mix remains limited, however, although most Arab countries have set ambitious targets to increase this capacity and framed policies for the transition.

7. In the United Arab Emirates, two utility-scale solar plants are operational; the Masdar City 10MW photovoltaic facility, since 2009, and the 100MW Shams 1 plant, since 2013. The low generating costs being achieved by the United Arab Emirates – below $2.50 per KWh recorded – gives photovoltaic technology potential for rapid growth. The country has developed models and data management systems to measure solar radiation, using maps for Global Horizontal Irradiation and Direct Normal Irradiation to study the potential of solar energy and the effect of soiling and dust deposits on performance. These investigations are aiding development of a cleaning mechanism to improve the performance of panels. Correct site selection for photovoltaic facilities is key to minimizing energy losses and reducing the costs of electricity generation that long-distance transmission would incur.

8. Participants discussed ways to increase the efficiency of photovoltaic energy by using it alongside other power sources, such as diesel generators. Such hybrid systems could be applied to great effect in rural areas, where off-grid systems are used and the ability to store energy is crucial. The cost of energy storage remains high, hindering uptake of this technology, but advances in battery design are expected to reduce costs and make photovoltaic/diesel systems more feasible in the future.

9. The use of renewable energy in the oil and gas industries was explored. Applications include enhanced oil recovery (EOR), water disposal, remote power and desalination. In Oman where large-scale renewable energy power plants are being developed, selecting the most appropriate technology and location has been critical to their success. One such success story has been an EOR pilot project in Miraah, where parabolic troughs – the most advanced solar technology – are used instead of large volumes of natural gas to inject steam for generating heat. Concentrated solar power (CSP) units were inserted into a commercial glass and steel greenhouse, which featured a sealing system suitable for desert environments due to its ability to withstand severe weather and sand storms. The 2017 pilot project has produced 1,021 MW of thermal energy and a steam output of 6,000 tons, saving 5.6 trillion British thermal units (Btus) per year of gas and 300,000 tons per year of CO_2 emissions.

10. Desert Technologies (DT) presented a case study on a small-scale reverse osmosis treatment plant using a photovoltaic system in the village of Al Ghreej in Iraq. The plant serves rural communities characterized by water scarcity and a mixed community of farmers, labourers, nomads and displaced people/refugees. Such projects offer significantly improved drinking water to remote populations.

B. Renewable energy in electricity production

11. The share of renewably energy in electricity production has been increasing worldwide, including in many Arab countries. The growth is focused on solar and wind, although in Algeria, a geothermal project also is planned. In general, renewable energy technologies consume less water than conventional sources when producing electricity due to negligible water requirements during the procurement stage. Renewable energy desalination projects in Arab countries have limited capacities, with only a small number of medium-sized plants operating. Such systems in the region use wind and solar technologies, although solar systems are most popular.

12. Water-energy demands in the United Arab Emirates are expected to continue rising steadily until 2025 due to population growth and substantial migration to urban areas. Various renewable energy projects, especially solar, are in the pipeline for the 2020-2030 period. Water desalination is one option to satisfy this increase in demand. Masdar is investing in research and development, and testing five desalination stations for greater energy efficiency and commercial advantages. Four companies are testing advanced reverse osmosis technologies, while a fifth is testing frontal osmosis technology. Based on initial results, the stations are working at twice the efficiency of standard heat technologies used to produce most of the Gulf region's drinking water.

13. In the twenty-first century, water and energy are key linked components of sustainable economic development. Meeting our water needs requires a systematic approach that integrates all end users, their energy requirements and associated economic and environmental costs. Solar photovoltaic pumps are one of the options for achieving clean water pumping and purification; off-grid photovoltaic water pumping desalination is another for remote areas. Integrating energy and water systems can achieve better energy efficiency and water security.

14. The Middle East and North Africa (MENA) region's desalination market is led by Saudi Arabia, followed by the United Arab Emirates. Twelve MENA countries are in the global top 20 for desalination capacity. Renewable energies offer a sustainable and secure way to desalinate, but such processes are energy intensive, hence the need for technologies that are less so. In the past, only small desalination plants in remote areas with no grid electricity have used renewable energy but research and development has enabled several larger pilot plants to operate successfully on solar energy. Different renewable energy technologies can be used for desalination, most commonly photovoltaic-driven reverse osmosis (PV-RO). The Middle East Desalination Research Center (MEDRC) has built different PV-RO systems that have been installed at four locations in Morocco. Autonomous PV-RO units installed in Ksar Ghilene village in Tunisia produced more than 6,000 cubic metres of drinking water in a period of 27 months. Saudi Arabia is working to harness large amounts of solar energy for water desalination with a project that is expected to substantially reduce production costs. Renewable technologies best used for desalination include solar thermal, photovoltaic, wind and geothermal energy. Concentrated solar power produces large amounts of heat suitable for thermal desalination. Photovoltaic and wind electricity are often combined with reverse osmosis or electrodialysis. Since electricity storage is still expensive, combining power generation and water desalination can be a cost-effective option for electricity storage when generation exceeds demand.

15. Lebanon, which still experiences electricity blackouts, is aiming to produce 12 per cent of its energy needs through renewables by 2020. This ambition has sparked interest in developing hydropower plants. Studies have been conducted on the potential to update irrigation channels and conveyers, waste-water treatment plants, thermal power plants and drinking water networks. Integrating hydro and other power plants is economically attractive and the private sector should be encouraged to invest in these technologies.

C. WATER ENERGY NEXUS – RENEWABLE ENERGY CASE STUDIES

16. Group 1: Renewable energy desalination. Many Arab countries are pursuing renewable energy projects, assessing options to reduce costs and increase efficiency. Participants at this session discussed the transition to renewables and how such technologies can save energy in the desalination process. They highlighted the need to: have a national transition strategy; invest in research and development and desalination technologies at country and regional levels; remove subsidies and encourage the private sector to play a bigger role; assess whether renewable technologies for desalination suit local needs; promote regional standards in renewable energy and desalination technologies; ensure sufficient local resources for renewable energy desalination projects; and build human, institutional and infrastructure capacities to develop a successful renewable energy sector.

17. Group 2: Renewable energy use in the power sector. In this session, participants discussed common challenges in the power sector. The first for many ESCWA member states is in the post-implementation phase, during continuous output monitoring and maintenance, when the lack of regular follow-up can cause system output to decrease. It was generally agreed the private sector could play a key role during this phase. Participants discussed the need for Arab countries to develop local manufacturing and promote technology transfer within the region, and for oil and gas price subsidies to be reduced to promote renewable energies.

18. Group 3: Water-energy nexus in energy recovery from wastewater operation. In this session, opportunities to recover energy from wastewater operations, including anaerobic digestion and sludge operations, were discussed, along with the challenges in using sludge to power waste-to-energy processes in wastewater treatment plants. Energy is mainly generated in anaerobic digestion treatment by breaking down organic matter into carbon dioxide (CO_2) and methane (CH_4) in the absence of oxygen. However, 70 per cent

of the gas collected is CH_4; the remaining is humidity and sulphur. A case study was presented of a treatment plant in the Syrian Arab Republic, where about 11,000 cubic metres of gas were generated daily. This represented 40 per cent of the plant's energy requirements, although system efficiency is low and needs to be improved. Recent technologies are resulting in more efficient, cost-effective power generation, but to exploit these advances, plant infrastructure needs to be updated. In another case study from Egypt, participants heard that household sludge collected from centralized units could be treated and converted to energy at great profit to the system. Replicating these projects in other Arab countries requires national financing sources, legislative frameworks, creating markets for sludge treatment for heat generation and soil conditioning, and raising awareness among policy and decision makers of the energy potential of sludge handling.

D. WATER ENERGY NEXUS COUNTRY PILOT PROJECTS

19. This session focused on pilot projects in Egypt, the Syrian Arab Republic and Tunisia using photovoltaic-water pumps and micro hydro-turbines with technical assistance provided by ESCWA under the United Nations Development Account project.

20. The Syrian project includes a photovoltaic water pumping system spanning three locations in Suwayda. Details of the three sites, along with information on solar radiations, humidity percentages and horse power of the pumps were provided.

21. In Chrichira, Tunisia, pumps of various power ratings and several reservoirs are used to transport water from higher to lower altitudes. The goal is to reduce the energy consumption of the network's hydraulic system by installing a hydroelectric micro-turbine. Local authorities and ESCWA will help to assess the technical and economic feasibility of this micro-hydroelectricity venture.

22. Participants discussed a proposed irrigation project in Egypt, which will depend on pumping large volumes of groundwater, the energy for which could be provided by solar photovoltaic sources. Among the many challenges is selecting the most suitable technologies for harsh desert conditions and assembling the human resources to build and maintain the project. The technical feasibility of this project is awaiting further data.

E. KEY PERFORMANCE INDICATORS AND FINANCIAL IMPLICATION FOR THE WATER-ENERGY NEXUS

23. A presentation was made on the key performance indicators and financial implications for renewable energy technologies. Developing indicators is a continuous process that can be improved. No clear indicators for the nexus are available yet but some indicators could be identified for renewable energies.

24. After the presentation, a discussion on renewable energy indicators and measuring performance highlighted that all Arab countries faced the same challenges, and that the substantial water losses needed to be reduced. Participants concluded the nexus was not merely a choice but a necessity in some countries.

F. WATER-ENERGY NEXUS COUNTRIES PROGRAMS AND INITIATIVES

25. This session opened with a presentation by the Head of Concessions and Partnership Service at Morocco's Ministry of Equipment, Transport, Logistics and Water, who said the country faces increasing stresses on water and energy due to demographic growth, urbanization and littoralization. To remedy this, energy efficiency should be optimized in the water sector, and funding in the water and energy sectors mobilized through public-private partnerships.

26. An overview of the water-energy nexus in Morocco revealed the country's many challenges are directly related to global water-energy problems, including: economic and social demands fuelled by demographic growth, climate change, and the need for energy efficiency and to mobilize water resources. The country's

water-energy sector started in 2002 and continues to evolve. In 2009, it developed a national water plan based on demand, supply and protecting resources. Achievements include an installed hydropower capacity that represents 25 per cent of the country's overall capacity. Morocco is looking to add 10,100 MW of renewable energy by 2030 by combining hydro power with wind and solar.

27. In Sudan, 60 per cent of electricity production comes from the River Nile and its tributaries. Proposed ventures include the Hasad project to harvest rainwater – the second largest water source in the country after groundwater – and the Abou Rjala Dam project to generate electricity. The main barriers to launching these have been lack of funding and a specialist technical workforce.

28. The National Energy Research Center (NERC) in Jordan highlighted the €7 million solar water pumping project being funded by the European Union and implemented jointly by NERC and the Ministry of Environment. Other projects discussed included the regional MINARET initiative to strengthen cooperation within the MENA region by implementing the nexus approach to renewable energy technologies to mitigate climate change impacts, combat poverty and unemployment, and tackle the growing demand for energy, water and food.

29. In Mauritania, a country with abundant solar and wind resources, renewable energy is the obvious answer to energy needs in rural areas that are difficult to connect to the national grid. However, lack of profitability due to small populations and high poverty is a major barrier to projects.

30. As part of efforts to reduce the gap between electricity consumption and production, various renewable energy technologies have emerged in Lebanon. One photovoltaic project is the Beirut Solar Snake facility, with 1MW operational and a total of 10MW capacity installed. Solar water pumping projects have been developed in Dair Al Ahmar, Keb Elias, Younin and Terbol, although this has been coupled with unsustainable groundwater pumping. These projects, along with exploration for oil and gas, will help fill the gap and increase electricity production. The cost of photovoltaic production has been declining in the past couple of years, and this, along with attractive financial schemes and low interest rates are encouraging the people to invest in renewable energy technologies in Lebanon.

31. In Lybia, oil accounts for 94 per cent of the country's revenue from foreign exchange, but there is enormous potential for renewable energy from solar and wind. Libya aims to increase the share of renewables in its energy mix from 3 per cent in 2015, to 7 per cent in 2020 and 10 per cent in 2025.

32. In the State of Palestine, solar water heater and photovoltaic systems are being installed in hospitals and for well pumping in the agricultural sector. By 2020, it is projected that 10 per cent of the total energy mix will come from renewable energy sources, mainly solar and wind.

33. The key messages at the closing of this session included: there is significant potential for renewable energy desalination in several Arab countries; developing national indicators is important for monitoring, assessing and improving related processes; and exchanging best practices and lessons learned is at the essence of regional collaboration. However, challenges remain, such as the need to secure flexible financing for water-energy nexus projects and conventional energy subsidies.

34. After the workshop, separate meetings were organised, with teams established at country level (Egypt, Syrian Arab Republic, Tunisia) to conduct feasibility studies for each selected pilot project.

II. ORGANIZATION OF WORK

A. VENUE AND DATE

35. The Regional Policy Workshop on the Water-Energy Nexus was organized on 11-12 July 2017 in Beirut.

B. Opening

36. The meeting was formally opened by Ms. Carol Chouchani Cherfane, Chief of the Water Resources Section, Sustainable Development Policies Division, ESCWA, and Ms. Radia Sedaoui, Chief of the Energy Section, Sustainable Development Policies Division, ESCWA.

C. Participants

37. The workshop was attended by 42 participants, including experts and technical managers from water and energy ministries, national utility companies and the private sector, and consultants and representatives from specialized Arab and international organizations and research institutions.

D. Agenda

38. Presentations and discussions were made over eight sessions:

(a) Opening session and introduction;
(b) Renewable energy for water and wastewater applications;
(c) Renewable energy in electricity production;
(d) Water-energy nexus: renewable energy case studies;
(e) Water-energy nexus country pilot projects;
(f) Key performance indicators and financial implication for the water-energy nexus;
(g) Water-energy countries programmes and initiatives;
(h) Closing session.

E. Evaluation

39. An evaluation questionnaire was distributed to participants to assess the meeting's relevance, effectiveness and impact. The feedback received was positive, with most participants rating the overall quality of the meeting excellent (63 per cent) to good (31.4 per cent). The majority of participants said the meeting achieved its objectives and agreed expectations were satisfactorily met.

40. About 85 per cent of participants submitted completed questionnaires. The majority found the organization of the meeting excellent (66 per cent), while just over a half (51.4 per cent) said their own expertise was well suited for the meeting. Most indicated the meeting represented a good forum for exchange of information and provided an important opportunity to share experiences with other experts and establish useful contacts. Written materials distributed by ESCWA and presentations by contributing experts were deemed of good quality.

41. All participants agreed on the need for follow-up meetings. Many suggested follow-up action on desalination, while others suggested a regular forum to enable participants to stay in touch and share their country's information. Finally, some called for water-energy indicators specific to the region and a water-energy nexus for ESCWA countries.

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